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DIVICE FOR MANUFACTURING LIQUID CRYSTAL DISPLAY ELEMENT

[Abstract]

PROBLEM TO BE SOLVED: To provide a device for manufacturing a liquid crystal display element in which two transparent substrates are precisely positioned.

SOLUTION: The device for manufacturing a liquid crystal element 100 makes a liquid crystal material uniformly held between lower and upper substrates by dropping the liquid crystal material 16 on the lower substrate 12 composed of a light-transmissive material and by sticking the upper substrate 14 composed of a light-transmissive material on the liquid crystal material in an evacuated atmosphere. In the device, a lower suction mechanism 24 is arranged below the lower substrate so as to be horizontally movable and is provided with plural suction holes 48 on the surface opposite to the lower substrate. Also an upper suction mechanism 28 is arranged on the upper substrate and is provided with plural suction holes 54 on the surface opposite to the upper substrate. Then an elastic

sheet 50 containing no airtight structure is arranged between the lower substrate and the lower suction mechanism or between the upper substrate and the upper suction mechanism.

[Claim(s)]

[Claim 1] In an apparatus for manufacturing a liquid crystal display element, which drips liquid crystal material on a lower substrate made of transparent material and joins an upper substrate made of transparent material with the lower substrate having the liquid crystal material thereon at an atmosphere of vacuum, thus retaining the liquid crystal material uniformly between the lower and upper substrates, the apparatus comprising:

a lower absorber disposed under the lower substrate movably in a horizontal direction, having a plurality of absorption openings on a surface thereof opposite to the lower substrate;

an upper absorber disposed over the upper substrate, having a plurality of absorption openings on a surface thereof facing the upper substrate; and

an elastic sheet arranged between the lower substrate and the lower absorber or between the upper substrate and the upper absorber, not having an airtight structure.

[Claim 2] The apparatus for manufacturing the liquid crystal display element

as recited in claim 1, wherein the elastic sheet is made of silicon or fluorine.

[Claim 3] The apparatus for manufacturing the liquid crystal display element as recited in claim 1 or 2, wherein the elastic sheet includes a plurality of perforations penetrated in a thickness direction.

[Claim 4] The apparatus for manufacturing the liquid crystal display element as recited in claim 3, wherein each of the perforations is arranged to connect with corresponding absorption openings of the lower absorber or the upper absorber adjacent to the elastic sheet.

[Claim 5] The apparatus for manufacturing the liquid crystal display element as recited in claim 3 or 4, wherein a diameter of the perforation is 5mm and less.

[Claim 6] The apparatus for manufacturing the liquid crystal display element as recited in claims 3 to 5, wherein the perforations of the elastic sheet are formed in a region that covers the perforations of the lower absorber or the upper absorber adjacent to the elastic sheet.

[Claim 7] The apparatus for manufacturing liquid crystal display element as recited in claims 3 to 5, wherein the perforations of the elastic sheet occupy a dimension of 10% or more in the region that covers the perforations of the lower absorber or the upper absorber adjacent to the elastic sheet.

[Claim 8] The apparatus for manufacturing the liquid crystal display element as recited in claims 3 to 7, wherein a polyethylene sheet is arranged on a surface of the elastic sheet opposite to the lower substrate and has perforations formed at positions corresponding to the perforations of the elastic sheet.

[Claim 9] The apparatus for manufacturing the liquid crystal display element as recited in claims 3 to 7, wherein a layer made of fluorine or Teflon is coated on a surface of the elastic sheet facing the lower substrate and has perforations formed at positions corresponding to the perforations of the elastic sheet.

[Title of the Invention]

APPARATUS FOR MANUFACTURING LIQUID CRYSTAL DISPLAY ELEMENT

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to an apparatus for manufacturing liquid crystal display element used as a video (image) display panel, such as a computer equipment, television receiver, etc.

[Description of the Prior Art]

Fig. 6 shows illustratively a section of a general liquid crystal display element. As shown in the figure, the liquid crystal display element 10 includes a lower substrate 12, made of a transparent material (e.g., glass); an upper substrate 14, made of the same transparent material; and liquid crystal material 16 injected between the lower and upper substrates 12 and 14. Besides, electrodes, not depicted, are arranged on the surface of the lower and upper substrates 12 and 14. The adhesion of the lower and upper substrates 12 and 14 is done by adhesive agent 18 distributed consecutively along with the fringe of both substrates. The adhesive agent 18 includes spacers 20 of spherical shape having a particular

dimension (e.g., 5μm in outside diameter). By virtue of the spacers 20, the gap between the lower and upper substrates 12 and 14 is maintained to have a fixed value (the same value with the diameter of the spacer).

The liquid crystal display element 10 is manufactured in accordance with the processes depicted in Fig. 7. To explain concretely, the adhesive agent 18 of ultraviolet hardening is applied consecutively along with the fringe of the lower substrate 12 (Process-a). Although not depicted, the spacers 20 shown in Fig. 6 are included in the adhesive agent 18. Besides, the application thickness of the adhesive agent 18 is about 30μm in general. Next, the liquid crystal material 16 is uniformly dripped on the surface of the lower substrate 12 within the region surrounded by the adhesive agent 18 (Process-b). Subsequently, the lower substrate 12 having the liquid crystal material 16 is put on an elastic sheet 22 on a lower absorber 24. Then, in an atmosphere of vacuum 26, the upper substrate 14 absorbed by an upper absorber 28 is pulled down to press and spread the liquid crystal material 16 on the lower substrate 12, thus contacting the liquid crystal material 16 with the adhesive agent 18. Next, by operating the lower absorber 24 in a horizontal direction, the lower substrate 12 is positioned correctly against the upper substrate 14. Under the present condition, the upper substrate 14 descends by the upper absorber 28 and the gap between the lower and upper substrates 12 and 14 is pressurized till it has a predetermined value (the diameter of the spacer).

Finally, the adhesive agent 18 is hardened using an ultraviolet lamp 30 irradiating ultraviolet rays 32, thus perfecting the liquid crystal display element 10.

However, the conventional apparatus for manufacturing the liquid crystal display element adopts a structure where the elastic sheet 22 disposed between the lower substrate 12 and the lower absorber 24 contains bubbles (i.e., airtight structure). To that end, when the elastic sheet 22 is put into the atmosphere of vacuum 26, the bubbles contained are expanded. In addition, when pressurizing the upper substrate 14 to the lower substrate 12, the lower substrate 12 aligned with the upper substrate 14 may be moved in the horizontal direction due to the presence of the bubbles expanded, thus deviating from each other.

Accordingly, an object of the present invention is to provide an apparatus for manufacturing liquid crystal display element that can produce a liquid crystal display element, of which a lower substrate is aligned precisely with an upper substrate, not deviating from each other when pressurizing the upper substrate to the lower substrate.

[Means for Solving the Problem]

To accomplish the object described above, the present invention improves the apparatus for manufacturing the liquid crystal display element, which drips liquid crystal material on a lower substrate made of transparent material and joins an

upper substrate made of transparent material with the lower substrate having the liquid crystal material thereon at an atmosphere of vacuum, thus retaining the liquid crystal material uniformly between the lower and upper substrates, the apparatus comprising: a lower absorber, disposed under the lower substrate movably in a horizontal direction, having a plurality of absorption openings on a surface thereof opposite to the lower substrate; an upper absorber, disposed over the upper substrate, having a plurality of absorption openings on a surface thereof faced with the upper substrate; and an elastic sheet (desirably, a sheet made of silicon or fluorine), arranged between the lower substrate and the lower absorber or between the upper substrate and the upper absorber, not having an airtight structure.

According to the apparatus for manufacturing liquid crystal display element of the invention, since the elastic sheet arranged between the substrate and corresponding absorber has an airtight structure (i.e., the structure that doesn't contain hermetic bubbles), the elastic sheet is not expanded even when it is put in the atmosphere of vacuum. Accordingly, even when pressurizing the upper substrate to the lower substrate, the elastic sheet is transformed only in the direction of pressurization, but not transformed in the direction crossed with the direction of pressurization (e.g., in the horizontal direction). Thereby the position relation for horizontal direction of both substrates already aligned is not distorted when pressurizing, thus obtaining a liquid crystal display element having both

substrates arranged with a suitable position relation.

The apparatus for manufacturing liquid crystal display element in accordance with another embodiment of the present invention has a plurality of perforations penetrating the elastic sheet in a direction of thickness. According to the apparatus for manufacturing liquid crystal display element, it is possible to prevent the substrate from being moved from corresponding absorber since the absorption force of the absorber can be acted upon the substrate closed to the elastic sheet interposed between the substrate and the absorber.

According to the apparatus for manufacturing liquid crystal display element in accordance with another embodiment of the invention, each of the perforations of the elastic sheet is arranged to connect with corresponding absorption opening of the lower absorber or the upper absorber adjacent to the elastic sheet. Besides, according to the apparatus for manufacturing liquid crystal display element in accordance with another embodiment of the invention, the perforations have a diameter of 5mm and less. In the apparatus for manufacturing liquid crystal display element in accordance with another embodiment of the invention, the perforations of the elastic sheet are formed in a region that covers the perforations of the lower absorber or the upper absorber adjacent to the elastic sheet. In addition, according to the apparatus for manufacturing liquid crystal display element in accordance with

another embodiment of the invention, the perforations of the elastic sheet occupy a dimension of 10% or more in the region that covers the perforations of the lower absorber or the upper absorber adjacent to the elastic sheet. According to the apparatus for manufacturing liquid crystal display element in accordance with the present invention, it is possible to convey the absorption forces of the absorbers to the substrates through the perforations, thus preventing the substrates from being moved when pressurizing the substrate.

Moreover, the apparatus for manufacturing liquid crystal display element in accordance with another embodiment of the invention includes a polyethylene sheet, arranged on a surface of the elastic sheet opposite to the lower substrate, having perforations established in positions corresponding to the perforations of the elastic sheet. According the apparatus for manufacturing liquid crystal display element, it is possible to detach the substrate from the elastic sheet readily after pressurization and adhesion. Besides, it is possible to provide a layer made of fluorine or Teflon coated on a surface of the elastic sheet faced with the lower substrate, instead of the polyethylene sheet, and to establish perforations in the coated layer in positions corresponding to the perforations of the elastic sheet.

[Embodiment of the Invention]

Hereinafter, most appropriate embodiments of the apparatus for

manufacturing liquid crystal display element in accordance with the present invention will be described with reference to accompanying drawings. Besides, in the description and accompanying drawings, common members and parts have the same reference numerals.

1. First embodiment: Figs. 1 to 3 depict an apparatus for manufacturing liquid crystal display element 100 (hereinafter referred to as "apparatus") and a portion of processes of manufacturing liquid crystal display element using the apparatus 100. In these figures, the apparatus 100 has a vacuum receptacle 40. The vacuum receptacle 40 includes a main body 42 having an opening part on the top thereof and a cover 44 for closing the opening part of the main body 42. Besides, the inside of the vacuum receptacle 40 is connected with a vacuum source through a conduit, all not depicted, coupled with a bottom part 45 of the main body 42, so as to make the inside space of the vacuum receptacle 40, touched with the bottom part 45, vacuous.

A lower absorber 24 is established on the bottom part 45 of the main body 42. The lower absorber 24 has a lower absorption plate 46. The lower absorption 46 has a surface processed to have a predetermined flatness and can be moved in a first horizontal direction and in a second direction orthogonal to the first direction by virtue of a horizontal movement instrument, not depicted. A plurality of

absorption openings 48 is formed in a predetermined region of the lower absorption plate 46 in a particular density or at regular intervals. Besides, the absorption openings 48 are connected to the vacuum resource described above. By introducing vacuum into the absorption openings 48, the lower absorption plate 46 can absorb and seize objects (concretely, an elastic sheet and a lower substrate, described below) on the surface of the lower absorption plate 46.

An elastic sheet 50 is disposed on the surface of the lower absorption plate 46. As an elastic sheet 50, a sheet having a structure that doesn't contain bubbles therein (airtight structure) is used. To adopt this structure, it is desired to apply silicon rubber or fluoric rubber as a material forming the elastic sheet 50.

In a process for manufacturing the liquid crystal display element, a lower substrate 12 containing liquid crystal material 16 retained by adhesive agent 18 applied and dripped is put on the elastic sheet 50. Then, an upper substrate 14 is put on the lower substrate 12 to be joined with each other, as shown in Figs 2 and 3.

Fig.2 illustrates a process for putting the upper substrate 14 on the lower substrate 12 to fasten both substrates 12 and 14. As depicted, in this process, an upper absorber 28 is disposed inside a vacuum receptacle 42. The upper absorber 28 has an upper absorption plate 52. The lower end of the upper absorption plate

52 is processed to have a predetermined flatness. Besides, a plurality of absorption openings 54 is formed in a predetermined region (concretely, the region that the upper substrate 14 described below is held) of the lower absorption plate 46 in a particular density or at regular intervals. These absorption openings 54 are connected to the vacuum resource described above through a conduit. By introducing vacuum into the absorption openings 54, the upper absorption plate 52 can absorb and seize an object (concretely, an upper substrate, described below) on the lower end of the upper absorption plate 52.

Seal members 56 are arranged between the main body 42 and the upper absorption plate 52 to form a hermetic space 58 under the upper absorption plate 52. The upper absorption plate 52 is supported by a lower end of a shaft 60 penetrating the cover 44. Meanwhile, a shaft elevator 62 fixed on the cover 44 is established on the top of the shaft 60. By driving the shaft elevator 62, the upper absorption plate 52 ascends and descends.

In a process for joining the lower substrate 12 to the upper substrate 14, the upper substrate 14 is arranged in a predetermined region under the upper absorption plate 52 and, then, vacuum is introduced into the absorption openings 54 so as to hold the upper substrate 14. The upper absorption plate 52 holding the upper substrate 14 is disposed inside the main body 42. Moreover, the cover 44 is

fixed to the main body 42. Next, in the same manner with the absorption openings 54, vacuum is introduced into the hermetic space 58 and the absorption openings 48 of the lower absorption plate 46. Under the present condition, the shaft elevator 62 is driven to descend the upper absorption plate 52.

As a result, the upper substrate 14 is pulled down to press and spread the adhesive agent 18 and the liquid crystal material 16 retained on the lower substrate 12 in the horizontal direction. Before the gap between the lower and upper substrates 12 and 14 has a predetermined value (5㎛), the lower absorption plate 46 is moved in the horizontal direction and the lower substrate 12 is appropriately positioned against the upper substrate 14 by virtue of the horizontal movement instrument. After positioning, the upper absorption plate 52 is pulled down more and the upper substrate 14 is pressurized to the lower substrate 12 until the gap between the lower and upper substrates 12 and 14 reaches a predetermined value (5㎛). Here, since the elastic sheet 50 of the airtight structure is not expanded even when introducing vacuum into the hermetic space 58, the lower substrate 12 is not moved in the horizontal direction when pressurizing the upper substrate 14 to the lower substrate 12. Accordingly, the relation between the lower and upper substrates 12 and 14 aligned in the horizontal direction is maintained up to an end product.

When the gap between the lower and upper substrate 12 and 14 has a particular value, the vacuum state of the hermetic space 58 is cancelled and the liquid crystal display element 10 is taken out from the main body 42 by means of the upper absorption plate 52. Ultraviolet rays are applied to the liquid crystal display element taken out to harden the adhesive agent 18, thus making an end product (refer to Fig. 7B).

2. Second embodiment: Fig. 4 illustrates the apparatus 100 in accordance with a second embodiment of the invention. In this apparatus 100, a plurality of perforations 72 is formed on the elastic sheet 70. Each of the perforations 72 is located correspondingly to the absorption openings 48 formed on the lower absorption plate 46 to be linked with each other when the elastic sheet 70 is positioned correctly on the lower absorption plate 46. Therefore, in accordance with the second embodiment of the present invention, the vacuum introduced into the absorption openings 48 of the lower absorption plate 46 acts the lower end of the lower substrate 12 via the perforations 72 of the elastic sheet 70. To that end, it is possible to position the lower substrate 12 correctly for the lower absorption plate 46 and, at the same time, to control the horizontal movement of the lower substrate 12 efficiently. Besides, since the lower substrate 12 can be adhered closely to the elastic sheet 70 without the gap by forming the perforations 72, it is possible to form the lower substrate 12 by imitating the shape of the upper substrate 14 and

maintain the gap between both substrates uniformly in the overall region with flexible materials chosen for the elastic sheet 70.

In addition, to absorb the lower substrate 12 thoroughly, it is desired that the ratio of penetration (the ratio of the dimension that the elastic sheet 70 is touched with the lower substrate 12 to the sum of the dimensions of the perforations 72) is set to more than 10% approximately. Moreover, in case that the diameter of the perforation 72 is excessively great, the areas of the lower substrate 12 adjacent to the perforations 72 are distorted. Thereby it is desired that the diameter of the perforation 72 is set to less than 5mm. The perforations 72 formed on the elastic sheet 70 should be limited to the dimension that the elastic sheet 70 is touched with both lower absorption plate 46 and lower substrate 12 so that the vacuum introduced into the absorption openings 48 of the lower absorption plate 46 operates on the lower substrate 12, not wasting the vacuum.

3. Third embodiment: Fig. 5 depicts the apparatus 100 in accordance with a third embodiment of the invention. In this apparatus 100, a plurality of perforations 72 is formed on the elastic sheet 70 in the same manner with the apparatus 100 in accordance with the second embodiment. A thin film sheet 80 made of polyethylene is interposed between the elastic sheet 70 and the lower substrate 12. Besides, a plurality of perforations 82 connected with the perforations 72 of the elastic sheet

70 is established on the thin film sheet 80. The vacuum introduced into the absorption openings 48 of the lower absorption plate 46 operates on the lower end of the lower substrate 12 effectively via the perforations 72 of the elastic sheet 70 and the perforations 82 of the thin film sheet 80.

In accordance with the apparatus 100 having the thin film sheet 80, when taking out the liquid crystal display element after pressurization, the lower substrate 12 can readily be detached from the lower absorber 24 by virtue of the thin film sheet 80. Thereby the lower substrate 12 will not be distorted by an unnecessary force acted on the lower substrate 12 when detachment.

Moreover, it is possible to provide a layer made of fluorine or Teflon coated on a surface of the elastic sheet faced with the lower substrate, instead of the polyethylene sheet. In this coated layer, perforations are formed in positions corresponding to the perforations of the elastic sheet. In addition, while the preferred embodiments thus far described disposes the elastic sheet and thin film sheet between the lower substrate and the lower absorption plate supporting the lower substrate, the elastic sheet and thin film sheet may be interposed between the upper substrate and the upper absorption plate supporting the upper absorption.

[Effect of the Invention]

As can be understood from the explanation described above, in accordance with the apparatus for manufacturing liquid crystal display element of the present invention, it is possible to maintain two substrates correctly aligned in the plane direction in the process of injecting liquid crystal material between the two substrates and pressurizing the two substrates. Besides, it is possible to take out the liquid crystal display element having the two substrates joined with each other from the apparatus without transformation.

[Description of Drawings]

Fig. 1 is a sectional plan showing a portion of an apparatus for manufacturing liquid crystal display element in accordance with the present invention;

Fig. 2 is a sectional plan illustrating a process for manufacturing liquid crystal display element and the apparatus for manufacturing liquid crystal display element in accordance with the invention;

Fig. 3 is a sectional plan depicting processes for manufacturing liquid crystal display element and the apparatus for manufacturing liquid crystal display element in accordance with the invention together with Figs 1 and 2;

Fig. 4 is a sectional plan representing processes for manufacturing liquid crystal display element and the apparatus for manufacturing liquid crystal display element in accordance with another embodiment of the invention;

Fig. 5 is a sectional plan depicting processes for manufacturing liquid crystal display element and the apparatus for manufacturing liquid crystal display element in accordance with another embodiment of the invention;

Fig. 6 is a sectional plan illustratively showing a liquid crystal display

element; and

Fig. 7 is a sectional plan explaining processes for manufacturing liquid crystal display element.